ISSN 0704-3716

Canadian Translation of Fisheries and Aquatic Sciences

No. 5158

Comparison of various methods of assessing water quality by means of oligochaetes

T. Slepukhina

Original title: (unknown)

In: A. Kangur (ed.), Biologiya presnovodnykh organizmov Severozapada SSSR. Gidrobiol. Issled. 14. Institute of Zoology and Botany, Academy of Sciences of the Estonian SSR, Tallin, U.S.S.R., p. 51-56, 1983
Original language: Russian

Available from:

Canada Institute for Scientific and Technical Information
National Research Council
Ottawa, Ontario, Canada K1A 0S2

1985

Fisheries & Oceans
LIBRARY
DEC 15 1986
BIBLIOTHÈQUE
Pêches & Océans

9 typescript pages

90-00102/

Secretary of State / Secrétariat d'État

MULTILINGUAL SERVICES DIVISION – DIVISION DES SERVICES MULTILINGUES

TRANSLATION BUREAU BUREAU DES TRADUCTIONS

LIBRARY IDENTIFICATION – FICHE SIGNALÉTIQUE

CTFAS 5158

Translated from - Traduction de	Into - En
Russian	English

Author - Auteur

Slepukhina, T.

Title in English or French - Titre anglais ou français

Comparison of various methods of assessing water quality by means of oligochaetes

Title in foreign language (Transliterate foreign characters)
Titre en langue étrangère (Transcrire en caractères romains)

Reference in foreign language (Name of book or publication) in full, transliterate foreign characters.
Référence en langue étrangère (Nom du livre ou publication), au complet, transcrire en caractères romains.

Gidrobiologicheskie issledovaniya

Reference in English or French - Référence en anglais ou français

Hydrobiological Research

Publisher - Éditeur	DATE OF PUBLICATION / DATE DE PUBLICATION			Page Numbers in original / Numéros des pages dans l'original
	Year / Année	Volume	Issue No. / Numéro	
Institute of Zoology and Botany, Academy of Sciences of the Estonian SSR				51-56
Place of Publication / Lieu de publication				Number of typed pages / Nombre de pages dactylographiées
Tallin, USSR	1983	14	–	9

Requesting Department / Ministère-Client: Fisheries and Oceans

Branch or Division / Direction ou Division: S.I.P.B.

Person requesting / Demandé par: R.O. Brinkhurst

Your Number / Votre dossier nº: – –

Date of Request / Date de la demande: March 18, 1985

Translation Bureau No. / Notre dossier nº: 1655875

Translator (Initials) / Traducteur (Initiales): P.J.H.

UNEDITED TRANSLATION
For information only
TRADUCTION NON REVISEE
Information seulement

MAY / MAI 13 1985

Canada

SEC 5-111 (R4 10)

CTFAS 5158

Comparison of Various Methods of Assessing Water Quality by Means of Oligochaetes

T. Slepukhina

In this article the term "water quality" means only one of the various aquatic characteristics, namely the degree of organic pollution of a body of water.

As is well known, the Oligochaeta are the group of invertebrates most frequently cited by various authors for purposes of bioindication. This is because massive concentrations of certain of them are observed at sites of heavy organic pollution. It is also well known that oligochaetes cannot serve as indicators of one-time or intermittent pollution (excepting in cases of catastrophic death or inordinately heavy loading), since the duration of their life cycle is quite long. They furnish information on the averaged state of the waters over a fairly long period antecedent to the time of observation, which is sometimes very important.

A number of methods exist for indicating water quality by means of oligochaetes. Some of them can only be discussed, in our opinion, with respect to the waters for which they were first proposed. Others are applicable in day-to-day work to waters of various types.

We shall examine some of these methods, as exemplified by waters of different geographic zones:

1. Lake Ladoga - the largest oligotrophic body of water in which powerful local foci of pollution by urban sewage and effluent waters from a pulp and paper combine are manifested.

2. The Sukhona River - a river extremely heavily polluted by waste products from a pulp and paper combine and which has a rapid current.

3. The shallow, well heated ponds of the Northern Caucasus, on the banks of which there are piggeries, poultry farms and dairy farms.

A number of investigators studying the American Great Lakes (Wright, 1955; Carr and Hiltunen, 1965; Howmiller and Beeton, 1971) are treating a high density of oligochaetes as an index of water pollution. 52

There is no reason to doubt that in waters of all types a mass development of oligochaetes, accompanied by a sharp decrease in the species composition of the benthos, serves as an index of an excessive amount of organic matter.

In Lake Ladoga, at some stations in the vicinities of the towns of Sortavala and Pitkyaranta, we observed concentrations of oligochaetes belonging to the species Tubifex tubifex or Limnodrilus hoffmeisteri and Potamothrix hammoniensis, where they numbered as many as 4,000 specimens/m^2.

In the Sukhona River the density of the concentrations of Limnodrilus udekemianus and Tubifex tubifex exceeded 5,000 specimens/m^2, reaching a maximum of 22,000 specimens/m^2 with a biomass of 475 g/m^2. Limnodrilus hoffmeisteri was noted in lesser numbers.

In the most polluted ponds (of the 147 that we investigated) in the Northern Caucasus, near the place where effluents from the farms were being discharged into them the numbers of oligochaetes averaged between 6,000 and 8,000 specimens/m^2, with a maximum value of 31,800 specimens/m^2. The Oligochaeta species composition was limited to Limnodrilus hoffmeisteri, L. udekemianus, L. helveticus, Tubifex tubifex, Potamothrix hammoniensis and Psammoryctides albicola.

It is necessary to point out that in the waters studied, belonging as they do to diverse types and situate in different geographic zones, the same species of oligochaetes are observed when there is heavy organic pollution. This identicality of species composition in heavily polluted sections of waters of disparate types is probably due to the fact that it is precisely the aggregate of the conditions resulting from the pollution which, in this instance, is the dominant environmental factor. The other factors have a less pronounced effect.

Unfortunately, in some cases oligochaetes are absent or not well represented at polluted sites. This is on account of an unfavourable oxygen regime, the absence of suitable soils, the existence of large numbers of predators, the presence of ions of heavy metals and other causes. Some authors (Finogenova and Alimov, 1976) therefore consider the absolute number of oligochaetes at polluted sites to be an unreliable criterion for analysis.

In our opinion, the method of Goodnight and Whitley (1961), which uses for analysis the percentage content of oligochaetes in a sample, is more to the point. According to the findings of these authors, if the oligochaetes number 60%, the river is in a good condition, and if they number between 60 and 80%, pollution is doubtful. But when the oligochaete population exceeds 80%, pollution is indisputable.

Our data for the Sukhona River corroborate this thesis (Aleksandrova, Slepukhina et al., 1977).

Nevertheless, this criterion cannot be used for Lake Ladoga since, as we have shown (Slepukhina, in press), oligochaetes constitute 50-96% of the fauna of the central part of that lake.

In the heavily polluted sections of the North Caucasian ponds, with an oligochaete density exceeding 6,000-8,000 specimens/m^2, the concentration of them in the samples was in the majority of cases higher than 80%, although in some of the ponds it amounted to 60% of the total numbers and to less than 30% by weight, which was on account of the abundant development of Chironomus f. l. plumosus.

The King and Ball index (King and Ball, 1964), i.e., the ratio of the mass of the insects to the mass of the oligochaetes, is far from universal for the same reasons as the method of Goodnight and Whitley. Moreover, at the same level of pollution a small admixture of insecticides alters this ratio in favour of the oligochaetes (Aston, 1973) and of the ions of heavy metals - in favour of the insects (Brinkhurst, 1966; Liperovskaya, 1970), and the seasonal dynamics and emergence of chironomids cause major fluctuations in the value of this index (Finogenova and Alimov, 1976).

The Zahner table (Zahner, 1965), which was compiled for Lake Bodensee, where the class of water purity depends on the ratio between the numbers of Tubifex tubifex and Limnodrilus, has not found confirmation in our findings and is evidently only significant in the case of Lake Bodensee and lakes of a similar type.

Although the Milbrink diagrams (Milbrink, 1973) can serve as a good illustration of the distribution of excessive organic matter in soils, in dissimilar waters the species compositon of the group indices will be somewhat disparate.

Parele and Astapenok (1975) are proposing for the Latvian rivers the index $D = \frac{T}{O}$, where T is the number of Tubificidae and O is the total number of Oligochaeta in the sample.

If D = 0.3 the waters are relatively pure;

When D = 0.3 - 0.55 there is slight pollution;

" D = 0.55 - 0.8 the rivers are polluted;

" D = 0.8 - 1.0 heavy pollution is observed.

In the Sukhona River and the ponds of the Northern Caucasus D almost everywhere equals 1. In Lake Ladoga D fluctuates between 0 and 1 (fig. 2) and apparently cannot serve as an indicator of pollution.

An overall analysis of the species composition of the entire community of the Oligochaeta does not give encouraging results (Brinkhurst, 1966). We also had been convinced of this in the case of the waters that were studied, as many species of Oligochaeta are exceedingly plastic (Finogenova, 1976).

Thus, a massive concentration of a small number of species of the Oligochaeta is unquestionably indicative of a large quantity of readily oxidisable organic matter. In light of this, right away one can additionally draw a series of important conclusions as to the condition of a body of water or a biotope:

1. No acute oxygen deficiency is being observed here;

2. The conditions are favourable as regards the salts of heavy metals, petroleum products and toxic chemicals; 54

3. The massive concentration of oligochaetes is giving rise to extremely intensive self-purification of the waters. It has been shown that every 24 hours (Alsterberg, 1922; Tsvetkov, 1969), oligochaetes rework a quantity of soil which is 9 times greater than their mass. For example, in the Sukhona River, at stations where the oligochaete density was 22,000

specimens/m^2 and the biomass was as high as 475 g/m^2, in each square meter of the bottom, 4 kg and 275 g of soil are being reworked in the summer every 24 hours, which amounts to 128 kg in a month.

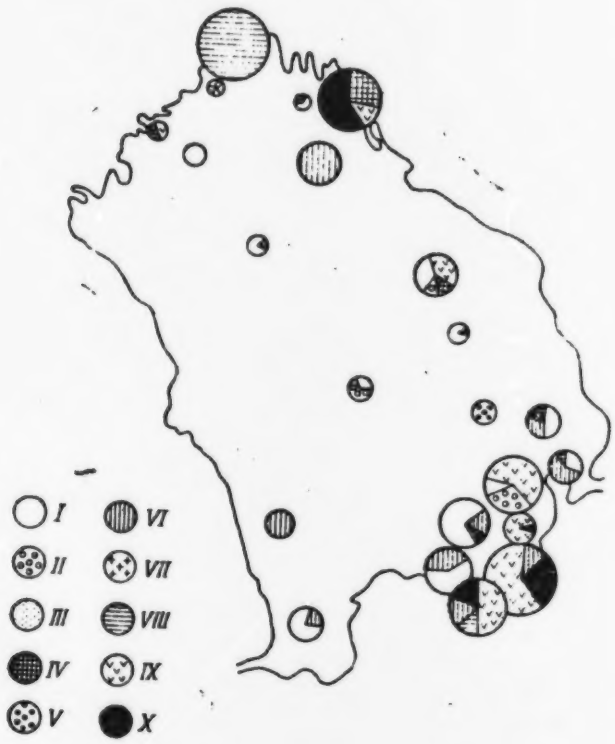
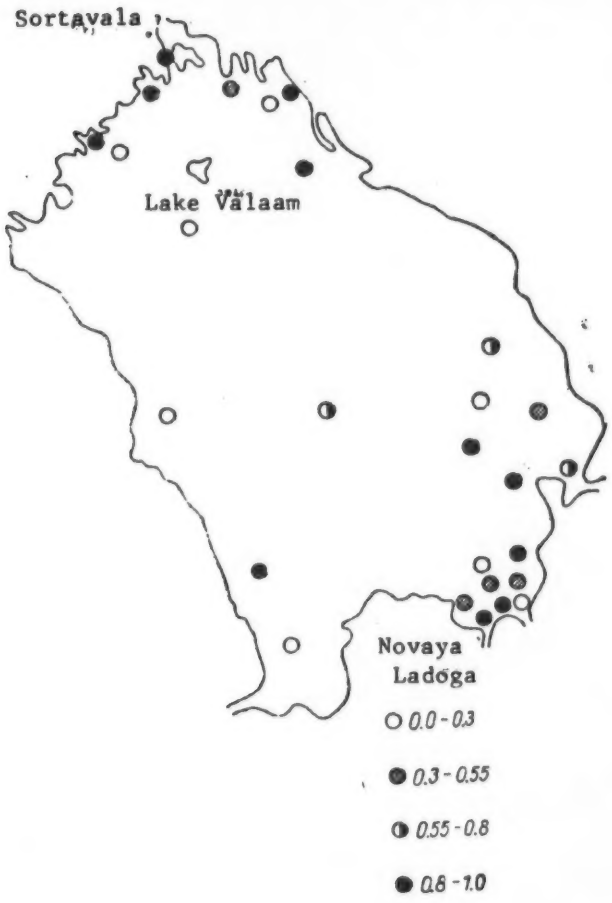


Fig. 1. Indication of organic pollution of Lake Ladoga, after Milbrink:
I - indices of a zone of pure waters;
X - indices of a zone of heavy organic pollution;
II - IX - indices of intermediate zones.



55

Fig. 2. Distribution of the D index values (after Parele and Astapenok) in Lake Ladoga.

References

56

1. Aleksandrova, D.N., Slepukhina, T.D., Senatskaya, N.Yu., Kulishev, A.V., Zheknovskaya, L.F., Okhlonkova, A.N., Veselova, M.F., and Kurochkina, A.A. Present condition and intensity of self-purification of the upper reaches of the Sukhona River. - Gidrobiol. zhurn. (Hydrobiological Journal), 1977, No. 2, pp. 89-91.

2. Liperovskaya, E.S. Some characteristics of the distribution of oligochaetes in relation to the pollution of the muds in the Moscow River. - In: Biological Processes in Sea Waters and Inland Waters. Abstract of a report to the 2nd Congress of the All-Union Hydrobiological Society. Kishinev, 1970, pp. 221-222.

3. Parele, E.A., and Astapenok, E.B. Tubificidae (Oligochaeta, Tubificidae) - indicators of water quality. - Izv. AN Latv. SSR, 1975, No. 9, pp. 44-46.

4. Slepukhina, T.D. Zoobenthos as an indicator of the water quality in dissimilar areas of Lake Ladoga (in press).

5. Tsvetkov, L.I. The role of saprobic oligochaetes in the oxygen balance of bodies of water. Author abstract of thesis for the degree of Candidate of Biological Sciences. Leningrad. 1969, 20 pp.

6. Finogenova, N.P. The significance of oligochaetes as indicators of polluted waters. - In: The Hydrobiological Principles of Self-Purification of Waters. Leningrad, 1976, pp. 51-60.

7. Finogenova, N.P., and Alimov, A.F. Assessing the degree of water pollution from the composition of benthic animals. - In: Methods of Biological Analysis of Fresh Waters. Leningrad, 1976, pp. 95-106.

8. Alsterberg, G. The respiratory mechanisms of the Tubificidae. - "Lunds Univ. Arsskr. N.F. Avd.", 1922, No. 18, 175 S.

9. Zahner, R. Organisms as indicators of water quality. "Arch. Hygiene und Bacteriologie", 1965, H. 3/4. S. 243-256.

ЛИТЕРАТУРА

1. Александрова Д. Н., Слепухина Т. Д., Сенатская И. Ю., Кулишев А. В., Жехновская Л. Ф., Охлопкова А. Н., Бесселова М. Ф., Курочкина Л. А. Современное состояние и интенсивность самоочищения верховьев р. Сухоны. — «Гидробиол. ж.», 1977, № 2, с. 89—91.
2. Линеровская Е. С. Некоторые особенности распределения олигохет в зависимости от загрязнения илов р. Москвы. — В кн.: Биологические процессы в морских и континентальных водах. Тезисы докл. II съезда ВГБО. Кишинев, 1970, с. 221—222.
3. Пареле Э. А., Астапенок Е. Б. Тубифициды *(Oligochaeta, Tubificidae)* — индикаторы качества водоема. — «Изв. АН Латв. ССР», 1975, № 9, с. 44—46.
4. Слепухина Т. Д. Зообентос как индикатор качества вод различных районов Ладожского озера (в печати).
5. Цветкова Л. И. О роли сапробных олигохет в кислородном балансе водоемов. Автореф. дисс. на соиск. уч. степ. канд. биол. н. Л., 1969, 20 с.
6. Финогенова Н. П. Значение олигохет как индикаторов загрязненных вод. — В кн.: Гидробиологические основы самоочищения вод. Л., 1976, с. 51—60.
7. Финогенова Н. П., Алимов А. Ф. Оценка степени загрязнения вод по составу донных животных. — В кн.: Методы биологического анализа пресных вод. Л., 1976, с. 95—106.
8. Alsterberg, G. Die respiratorischen Mechanismen der Tubificiden. — "Lunds Univ. Årsskr. N. F. Avd.", 1922, N 18, 175 S.

Aston, R. J. *Tubificidae* and water quality. — "Environmental pollution", 1973, 5, N 1, p. 1—10.

Brinkhurst, R. O. The *Tubificidae (Oligochaeta)* of polluted waters. — "Verh. Internat. Verein. Limnol.", 1966, N 16, p. 854—859.

Carr, J. F., and Hiltunen, J. K. Changes in the bottom fauna of western Lake Erie from 1939—1961. — "Limnol. and Oceanogr.", 1956, N 10, 551 p.

Goodnight, C. J. and Whitley, L. S. Oligochaetes as indicators of pollution. — Proc. 15th Indust. Waste Conf. Purdue Univ. Eng. Ext., 1961, Ser. 106, N 45, p. 139—142.

Howmiller, R. P. and Beeton, A. M. Biological evaluation of environmental quality, Green Bay, Lake Michigan. — "J. Water Pollution Control Federation", 1971, N 1, p. 123—133.

King, D. L. and Ball, R. C. A quantitative biological measure of stream pollution. — "J. Water Pollution Control Federation", 1964, vol. 36, N 5, p. 650—653.

Milbrink, G. Communities of *Oligochaeta* as indicators of the water quality in Lake Hjälmaren. — "Zoon", 1973, vol. 1, N 1, p. 77—88.

Wright, S. Limnological survey of western Lake Erie. — "U. S. Fish. and Wildlife Serv. Spec. Sci. Rept., Fisheries", 1955, N 139, 341 p.

9. Zahner, R. Organismen als Indicatoren für den Gewässerzustand. — "Arch. Hygiene und Bacteriologie", 1965, H. 3/4. S. 243—256.

COMPARISON OF VARIOUS METHODS OF ASSESSMENT OF WATER QUALITY BY MEANS OLIGOCHAETES

T. SLEPUKHINA

Summary

Various methods for stating organic enrichment were tested in the large oligotrophic Lake Ladoga, in the River Sukhona and in North-Caucasian ponds. The indices of Goodnight and Whitley (1961), King and Ball (1964), Zahner (1965), Parele and Astapenok (1975) as well as the general species composition proved to be unsuitable. The diagrams by Milbrink (1973) are of use when modified. The mass development of a small number of species always evidences an enrichment with easily decomposing organic matter; simultanously it shows the absence of acute oxygen deficit and toxic pollution. Oligochaetes are highly useful for the self-purification of water in such places.